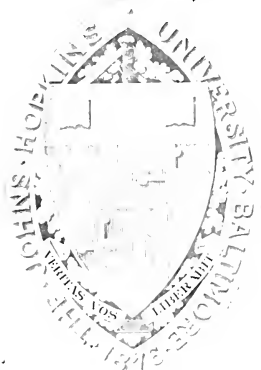THE CONDUCTIVITY, TEMPERATURE COEFFICIENTS OF CONDUCTIVITY,

AND DISSOCIATION OF CERTAIN ELECTROLYTES IN AQUEOUS SOLUTION

FROM 0° TO 35°.   PROBABLE INDUCTIVE ACTION IN SOLUTION,

AND EVIDENCE FOR THE COMPLEXITY OF THE ION.

D I S S E R T A T I O N

Submitted to the Board of University Studies of the Johns

Hopkins University in Conformity with the Requirements for

the Degree of Doctor of Philosophy,

By

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Baltimore,

June   -   1911.

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The Conductivity, Temperature Coefficients of Conductivity
and Dissociation of Certain Electrolytes in Aqueous Solution
from 0° to 35°.   Probable Inductive Action in Solution,
and Evidence for the Complexity of the Ion.

INTRODUCTION.
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This paper forms one of a series dealing with the
conductivity of electrolytes in aqueous solution.   In
it we shall take up for consideration the conductivity,
temperature coefficients of conductivity and percentage
dissociation of certain salts and shall endeavor to
show how these results confirm those already obtained;
and if possible point out new relations.   This work is
part of an investigation which has been carried on in
this laboratory for a dozen years or more.   The import-
ance of such an investigation is obvious, since chemistry
is a branch of the science of solutions and one of the
very best methods of studying solutions is the conducti-
vity method.

H I S T O R I C A L .

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Electrochemical theories were advanced as early as
1807 by Davy and by Berzelius.   Berzelius was among the
first to call attention to the electrically charged atom.
Faraday appeared later, giving to the world the laws which
bear his name.   His work has stood the test of time.
His law showing the relation between the quantity of elec-
tricity and amount of decomposition holds rigidly today,
and in the light of the electron theory takes on a new
meaning.   In the years 1853 to 1859 Hittorf determined
the relative velocities of the ions of many salts.   He
pointed out a relation between chemical activity and
conductivity, and also called attention to the analogy
existing between solutions and gases.   This latter
problem was taken up later by Raoult, Ostwold, Vant Hoff
and others.   The laws of Raoult dealing with the lowering
of the freezing point and vapor pressure of liquids, and
Ostwold's dilution law are well known.   Vant Hoff in 1887,
working on osmotic pressure found certain solutions which
behaved abnormally. Arrhenius attempting to explain their
behavior pointed out the fact that salts and analogous
substances break down into ions.   Thus was given to the
world the theory of electrolytic dissociation.   Its
truth is attested on every hand.   Facts once inexplicable

become wonderfully clear and lend confirmation to the theory.
Many workers have appeared in the field since Arrhenius.
The most important of these perhaps is Sir J. J. Thomson,
whose brilliant experiments have well-nigh revolutionized
our conception of matter.

The result of the work already done may be summarized
briefly as follows:- The conductivity of electrolytes in
solution is dependent primarily on two things, viz; the
number of ions and their velocity.   These two factors
may be affected by various others.   The most important
of these is temperature.   The effect of rise in tempera-
ture is chiefly to increase the velocity of the ions.
The number of ions would not be affected unless they were
complex.   In addition to the effect of temperature on
the number and velocity of ions in solution, there are
still other factors which for convenience may be divided
into three classes.

1. Those dependent upon the solute.

2. Those dependent upon the solvent.

3. Those dependent upon the combination of the
    solvent with the solute.

In class 1 - Factors dependent upon the solute, mention
should be made first of all of the effect of valence.
This would determine largely the number of ions capable
of entering into solution.   As is well known, the
conductivities of binary, ternary and quaternary compounds

are found to vary considerably.   Factors affecting the
velocity of the ion would be the atomic weight, and
atomic volume of the elements existing in the compound.
We would naturally expect that the velocity would be an
inverse function of the atomic weight and atomic volume.
Experimentally, however, this has not been found to be
true.   Jones and Pearce[1] found that those elements
which have the smallest atomic volumes have the greatest
hydrating power.   This would tend to diminish their
velocity.

As to the factors dependent upon the solvent, the
most important are its viscosity, its dielectric constant
and its association.

In class 3 should be placed the concentration of the
solution and the power of the solute and solvent to form
solvates with one another.   The conductivity of solutions
has been studied from each of these stand-points, and much
valuable data has been accumulated.

The effect of temperature has been worked out care-
fully by Jones and his co-workers, West[2], Jacobson[3], Clover[4],

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[1] Amer. Chem. J. _38_, 737, (1907).

[2] _Ibid;_   _54_, 357, (1905).

[3] Ibid.; _40_, 355, (1908).

[4] Ibid ; _45_, 187 (1910).

West[1], White[2], Wightman[3], and Hosford[4], Conductivity always increases with rise in temperature from 0°
to 65° while dissociation usually decreases slightly.
The decrease in dissociation would tend to diminish the
number of ions and thus to lessen the conductivity, but
this effect is more than offset by the increased velocity
of the ions due to rise in temperature. This decrease
in dissociation may be accounted for in two ways. It
may be due to a decrease in the association of the
solvent, which would tend to decrease the dissociation
of the dissolved substance, or it may be due to the fact
that a rise in temperature diminishes the dielectric
constant of the solvent and consequently its dissociating
power; since according to the Thompson - Nernst hypothesis
a substance having a high dielectric constant has great
dissociating power. While, as just shown, the effect
of temperature is to diminish the number of ions present,
its effect on the velocity of ions is just the reverse.
Rise in temperature increases the velocity of ions for
two reasons. First, it diminishes the viscosity of the
solvent. Secondly, rise in temperature would decrease

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[1] Amer Chem J, 44, 508, (1910).

[2] Ibid ; 44, 159, (1910).

[3] Ibid ; (1911).

[4] Ibid ; (1911).

the complexity of the hydrates formed. This also would
tend to increase the velocity of the ions. At all events,
the decrease in the number of ions seems to be more than
compensated for by the increase in velocity of the ions,
and the general effect of rise in temperature is, therefore,
an increase in conductivity.

The most important factor in its effect on conducti-
vity with rise in temperature is hydration. That the
dissolved substance combines with some of the solvent to
form solvates seems now to be an undisputed question,
since the existence of hydrates in solution is borne out
by several independent lines of indisputable evidence[1].
According to the law of mass action, hydration would be
greater in dilute than in concentrated solutions. If
this be true, conductivity should increase with dilution
and such has been found to be the fact. The close
connection between hydration and water of crystallization
has also been established in this laboratory.

Important relations between amount of hydration
and temperature coefficients of conductivity have been
pointed out. Jones and his co-workers, Bingham,
McMaster, Rouillar[2], Veazey , Guy, Davis, Reinhart,

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[1] Publication No. 60 of the Carnegie Institution of
Washington.

[2] Publication No. 80 of the Carnegie Institution of
Washington.

[3] *Amer. Chem. J.*, <u>41</u>, 433, (1909).

Schmidt[1], Kreider[2] and Nahin[3] have made important ob-
servations on the effect of viscosity on the conductivity
of electrolytes.

The work in the laboratory has been extended to
non-aqueous solutions. Apparatus has been improved, the
range of temperature has been extended, old sources of
error have been eliminated and the conductivities of
hundreds of compounds have been added to those already
measured.   The problem has been undertaken in this lab-
oratory of measuring the conductivity of all of the
more common acids, bases and salts in aqueous solution,
from 0° to 65°, and the calculation of the dissociation
whenever possible.

This work will be pushed forward as rapidly and
carefully as possible.

One fact overlooked thus far in the consideration
of the conductivity of electrolytes is the probable
inductive action[4] of the ion on the un-ionized molecule.
In the solution of a salt there is every condition necessary

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[1] Amer. Chem. J.   42, 37, (1909).

[2] Ibid.,   45, 282, (1911):

[3] Ibid.,   41, 433, (1909).

[4] See paper in American Chemical Journal by L. J. Winston,
to whom this entire suggestion and its applications in
this and the preceding paper are due.

for inductive action.   There are the charged ions, the
neutral molecules and the dielectric or solvent.   Ordinary
electrical induction in conductors, as is well known,
takes place as follows:-   A charged body brought near
to a neutral body, but separated from it by a dielectric,
causes a separation of the electricity in the neutral
body, drawing the opposite kind nearest to itself and
repelling the like charge to the side farthest from itself.
If while the charged body is still near, the repelled
charge in the conductor is removed by contact with some
other body, on the removal of the charged body, the once
neutral body would be left charged with the opposite
kind of electricity.   The ion, a charged body acting
through the water (a dielectric) on an un-ionized
molecule would produce just such an effect.   Several
results may follow from this.   First, a positive ion
brought near to a neutral molecule but separated from
it by the non-conducting water would cause a separation
of the electricity in the molecule; the negative will be
drawn near to itself and the positive repelled.   Suppose
for instance that the repelled charge is not removed,
the charged ion would simply attach itself to the molecule
and as a charged system move through the solution.
Moreover, this charged system could play the part of the
original ion and, acting through the water, in a similar
way draw other molecules to itself.   There would be a

limit, of course, to the number of molecules which could
thus be attached.   This no doubt would be a function
of the valency of the ion.

If, on the other hand, the repelled charge is
removed and the inducing ion then moves off, the once
neutral molecule would be left charged with a sign opposite
to that on the inducing ion, and moving through the
solution would be able to attract other molecules or
oppositely charged ions, to itself.   This of course,
would give rise to a great complexity of ions and molecules.
The velocity of the ions would thus be greatly affected,
because their masses would consequently be greatly in-
creased.   This may in a measure account for the apparent
discrepancy between the dissociation as found by the
freezing point method and that found by conductivity,
since by this inductive action there would be brought
about a change in the number of particles, which would
probably affect the dissociation as found by the
freezing point method.

The effect on conductivity on the other hand, would
be due rather to a change in the velocity of the ions.
The complex ions would tend to move more slowly than the
individual ion, thus making the conductivity measurements
of dissociation too low.   The change in the number of
particles would not be so apparent in the case of conduct-
ivity because, when by means of induction an ion attaches

itself to a neutral molecule, it would still give rise
to a charged system, and would not thereby reduce the
number of charged particles in solution. The breaking
up of these moving systems by heat would show in in-
creased temperature coefficients.

Jones and Pearce[1] have shown that the dissociation
as measured by the conductivity method is less than that
calculated from the freezing-point lowering. Conditions
were chosen such that the number of ions, velocity of
ions, hydration and viscosity were the same in both
cases. It was found by them that the greater the
dilution, the greater will be the difference in disso-
ciation as measured by the two methods. This is due to
the fact that the complexity of the hydrate is greater,
the greater the dilution.

Evidence seems to be accumulating in many directions
that the ions in solution are complex. Some interesting
relations are brought out in connection with the various
dilution laws, to which sufficient attention has not as
yet been directed; which apparently point to the
complexity of molecules in solution. Ostwald's Law,

$$\frac{\propto^2}{(1 - \propto)_V} \;\; = \;\; K$$

has been found to apply to weakly dissociated electro-
lytes, but not at all to strong electrolytes. Moreover,
various dilution laws have been formulated, which apply

Amer. Chem. Journal. 38, 745, (1907).

to strong electrolytes but are extremely unsatisfactory when the attempt is made to apply them to weaker electrolytes.

The question naturally arises, why this difference? The thought has suggested itself that it may be due to the complexity of the molecule – one dilution law applying to solutions containing molecules of a certain complexity, while another would apply to solutions containing molecules of a different order of complexity. Of the many dilution laws for strong electrolytes only two will be considered, viz:- that of Rudolphi and that of Van't Hoff. The Rudolphi formula is

$$\frac{\infty^2}{(1 - \infty)\sqrt{v}} = K.$$

Van't Hoff's is

$$\frac{\infty^3}{(1 - \infty)^2 v} = K.$$

Since the Ostwald law $\dfrac{\infty^2}{(1 - \infty)v} = K$ applies

to weakly dissociated electrolytes,- it may be assumed that, in solutions to which it applies, there are very few ions. If the Rudolphi formula is applied to a solution, a certain volume V_1 is obtained corresponding to a definite value for ∞ and for K. If now retaining the same values as before for ∞ and for K, the Ostwald formula is applied to the same solution, there is

obtained a volume V which is the square root of the
volume obtained by the Rudolphi formula.   In other
words, there is found the relation $\sqrt{V_1}$ / V = 1,   a
realtion which would indicate complexity of the molecule
in solutions to which the Rudolphi formula applies.
Treating the Van't Hoff formula in the same way, i.e.
comparing the volume obtained by the use of the Van't
Hoff formula with a certain solution for a definite value
of ∞ and of K, with the volume obtained by the use of
the Ostwald formula for the same solution, keeping ∞
and K the same as before, there is found the relation

$$\frac{V}{V_1} = \frac{\infty}{1 - \infty}$$

where V represents the volume when the Ostwald law was
applied and V_1 the volume obtained when the Van't Hoff
law was used.   Now if V/V_1= Constant , the molecule
would be simple in each case, but on examining the for-
mula it is readily seen that the relation is not a
constant one but that it is a function of the dissociation.
This would indicate complexity of the molecule in solu-
tions to which the Van't Hoff law applies.   The inter-
esting fact about this last relation is that the degree
of complexity varies with the dissociation, i.e. with
the number of ions present ; just exactly what has been
referred to above as the probable result of inductive

action.   But let us turn to the consideration of the

data in hand[1].

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[1] It should be stated that all of the above relations

have been worked out entirely independently by

L. G. Winston.

EXPERIMENTAL.

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The well-known Kohlrausch method was used to determine the conductivities. A Kohlrausch slide-wire bridge was employed with an induction coil and telephone receiver. The cells used were of the type designed by Jones and Bingham[1]. The cell constants were redetermined at regular, short intervals. The measurements were made at 0°, 12.5°, 25°, and 35°. Three separate readings were taken for each solution at each temperature different resistances being used for each reading. The average of the conductivities obtained by using each of these readings was taken to be the correct conductivity.

The flasks and burettes were carefully calibrated at 20° by the method of Morse and Blalock[2]

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[1] *Amer. Chem.* Journal. __34__, 493 (1905).

[2] Ibid.; __12__, 479 (1894).

S O L U T I O N S .

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Kohlbaum's "chemically pure" materials were taken as the starting point in almost every case. These were purified, whenever practicable, by crystallization. A solution somewhat more concentrated than the most concentrated solution to be used was made up. Its strength was determined by volumetric or gravimetric methods, and the solutions prepared from it as a mother solution. This solution was made by direct weighing whenever it was possible, and in the data below this method was always used unless otherwise stated.

W A T E R .

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The water used in making the solutions was prepared according to the method of Jones and Mackay[1] which has been employed in this laboratory for many years. This method is too well known to need discussion here. This water at $0°$ had a conductivity of about 0.9 to 1.3 $\times 10^-$.

Amer. Chem Journal, 19, 91, (1897).

D I S C U S S I O N   O F   R E S U L T S .

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The following salts have been classified approxi-
mately according to the position of the metal in the
Periodic System.   The ammonium, potassium and sodium
compounds would, therefore, be first in order.   I shall
group these together for consideration.   A careful ex-
amination of the results for these compounds will show
some points of interest.

(1). The difference in the conductivities of the binary,
ternary and quaternary salts is quite evident. The
conductivity of ammonium nitrate, potassium acetate, and
potassium permanganate between 0° and 35° ranges from 46
at 0°, in the most concentrated solution of potassium
acetate, to 163.69 at 35° in the most dilute solution of
ammonium nitrate.   The conductivity of those compounds
which are not binary, viz: ammonium sulphate, acid
ammonium sulphate, di potassium phosphate, sodium sulphate,
and borax, at 35° in the most dilute solutions is, in
every case, above 200 ; and in acid ammonium sulphate is
considerably above 500.

The very high values for the temperature coeffi-
cients of conductivity expressed in conductivity units,
in the case of the four sulphates, is very noticeable.
The highest values are 5, 6, and 7+ in the case of

sodium sulphate, ammonium sulphate and acid ammonium
sulphate respectively; while in the other salts under
consideration in this group, the temperature coeffi-
cients in conductivity units is 4 +.   This is
probably due to the fact that sulphates show a tendency
towards polymerization.

The very largest temperature coefficient of conduct-
ivity of this group belongs to acid ammonium sulphate.
It is 7.96.   This is doubtless accounted for by the
fact that this salt breaks up into very complex ions.

In the case of potassium acetate and potassium per-
manganate, it is somewhat peculiar that the temperature
coefficients of conductivity in per cent is in both cases,
from 0° through 25°, larger than those measured in
conductivity units.

It is also striking that in the case of acid ammonium
sulphate the temperature coefficients of conductivity
decrease with rise in temperature.

In dealing with the *following* data the percentage
dissociation will not be discussed for the individual
salts but by means of curves which will be given at the
end of the data, their points of difference will be brought
out.

AMMONIUM NITRATE.

Table I. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
2	58.44	78.92	101.51	119.48
8	64.35	84.25	113.38	135.07
32	68.81	94.30	123.13	146.53
128	71.64	98.45	128.44	152.92
512	73.63	101.39	132.64	157.48
1024	74.69	102.51	134.43	159.44
2048	75.25	103.39	134.79	160.39
4096	76.37	105.51	137.87	163.62

Table II. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per. Cent.	Cond. Units.	Per Cent.
2	1.64	2.81	1.81	2.29	1.80	1.77
8	1.59	2.47	2.33	2.77	2.17	1.91
32	2.04	2.97	2.31	2.45	2.34	1.90
128	2.15	3.00	2.40	2.44	2.45	1.91
512	2.22	3.02	2.50	2.47	2.48	1.87
1024	2.23	2.99	2.55	2.49	2.50	1.86
2048	2.25	2.99	2.52	2.44	2.56	1.90
4096	2.33	3.05	2.59	2.46	2.58	1.87

Table III. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
2	76.5	74.8	73.6	73.0
8	84.2	79.9	82.2	82.6
32	90.1	89.4	89.3	90.0
128	93.8	93.3	93.2	93.5
512	96.4	96.1	96.2	96.3
1024	97.8	97.2	97.5	97.5
2048	98.5	98.0	97.8	98.0
4096	100.0	100.0	100.0	100 0

AMMONIUM SULPHATE.

Table IV. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
2	82.37	112.09	145.09	170.72
8	98.06	136.28	179.57	213.19
32	115.27	160.26	210.98	254.86
128	130.95	182.65	241.38	291.69
512	139.69	195.77	259.21	313.00
1024	143.84	202.31	267.62	322.55
2048	150.62	209.74	275.96	337.47
4096	150.44	211.55	280.82	340.32

Table V. - TEMPERATURE COEFFICIENTS.

	0° - 12.5°		12.5° - 25°		25° - 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
2	2.38	2.89	2.64	2.36	2.56	1.76
8	3.06	3.12	3.46	2.54	3.36	1.87
32	3.60	3.12	4.06	2.53	4.39	2.08
128	4.14	3.16	4.70	2.57	5.03	2.08
512	4.49	3.21	5.08	2.60	5.38	2.08
1024	4.68	3.25	5.22	2.58	5.49	2.05
2048	4.73	3.14	5.30	2.53	6.15	2.23
4096	4.89	3.25	5.54	2.58	5.95	2.12

Table VI. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
2	54.6	52.9	51.6	50.1
8	65.0	64.4	63.9	62.6
32	76.5	75.7	75.1	74.8
128	86.9	86.3	85.9	85.7
512	92.7	92.5	92.3	91.9
1024	95.4	95.6	95.2	94.7
2048	100.0	99.1	98.2	99.1
4096	99.8	100.0	100.0	100.0

ACID AMMONIUM SULPHATE.

Table VII. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
2	155.26	186.49	211.99	236.06
8	183.40	223.84	258.00	277.18
32	223.58	279.55	322.68	349.24
128	265.24	339.00	404.14	444.74
512	289.79	378.25	463.20	522.24
1024	295.22	386.88	483.51	547.05
2048	303.41	400.01	496.86	573.46
4096	304.26	401.96	497.11	576.66

Table VIII. - TEMPERATURE COEFFICIENTS.

	0° - 12.5°		12.5° - 25°		25° - 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
2	2.50	1.61	2.04	1.09	1.41	0.66
8	4.04	2.20	2.73	1.22	1.91	0.74
32	4.48	2.00	3.45	1.23	2.66	0.82
128	5.90	2.22	5.21	1.54	4.06	1.01
512	7.08	2.44	6.79	1.80	5.90	1.27
1024	7.33	2.48	7.73	2.00	6.35	1.31
2048	7.73	2.55	7.74	1.94	7.66	1.54
4096	7.81	2.57	7.61	1.89	7.96	1.60

Table IX. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
2	51.0	46.4	42.7	39.2
8	60.3	55.7	51.9	48.1
32	73.5	69.6	65.0	60.6
128	87.1	84.4	81.3	77.1
512	95.2	94.2	93.2	90.5
1024	97.0	96.3	97.4	94.9
2048	99.7	99.6	99.9	99.4
4096	100.0	100.0	100.0	100.0

SODIUM SULPHATE.

Table X. — CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	68.49	97.54	129.13	156.71
8	78.51	111.46	146.40	178.24
32	94.51	132.73	172.76	215.19
128	107.54	152.49	203.10	247.02
512	117.46	166.24	221.21	269.50
1024	119.65	169.61	226.34	276.92
2048	125.95	176.08	235.35	287.02
4096	127.73	181.61	243.42	294.46

Table XI. — TEMPERATURE COEFFICIENTS.

v.	0° — 12.5°		12.5° — 25°		25° — 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	2.32	3.39	2.53	2.59	2.76	2.14
8	2.63	3.35	2.80	2.51	3.18	2.17
32	3.05	3.23	3.52	2.65	3.84	2.17
128	3.59	3.34	4.05	2.66	4.39	2.16
512	3.90	3.32	4.40	2.65	4.83	2.18
1024	4.00	3.34	4.54	2.68	5.06	2.19
2048	4.01	3.18	4.74	2.69	5.17	2.20
4096	4.31	3.37	4.94	2.72	5.11	2.10

Table XII. — PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	53.6	53.7	53.1	53.2
8	61.4	61.4	60.1	60.5
32	73.9	73.1	72.6	73.0
128	84.1	84.0	83.4	83.9
512	91.9	91.6	90.9	91.5
1024	93.6	93.4	93.0	94.0
2048	96.5	97.0	96.7	97.4
4096	100.0	100.0	100.0	100.0

BORAX.

Table XIII. — CONDUCTIVITY.

..	0°	12.5°	25°	35°
16	57.00	85.76	113.54	139.83
32	64.36	93.74	125.49	154.61
128	72.87	104.81	141.78	174.53
512	78.04	112.32	152.00	187.97
1024	79.30	113.39	155.40	189.37
2048	83.45	119.55	161.25	198.31
4096	85.50	122.28	163.99	202.65

Table XIV. — TEMPERATURE COEFFICIENTS.

	0° — 12.5°		12.5° — 25°		25° — 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
16	2.30	3.35	2.38	2.84	2.63	2.32
32	2.37	3.53	2.62	2.83	2.91	2.32
128	2.56	3.51	2.95	2.82	3.28	2.32
512	2.73	3.50	3.18	2.83	3.60	2.37
1024	2.73	3.45	3.21	2.83	3.60	2.35
2048	2.89	3.40	3.33	2.79	3.71	2.30
4096	2.94	3.44	3.34.	2.73	3.87	2.36

Table XV. — PERCENTAGE DISSOCIATION

v.	0°	12.5°	25°	35°
16	67.8	68.5	69.2	69.0
32	75.3	75.8	76.5	76.3
128	85.3	85.7	86.4	86.1
512	91.3	91.8	92.7	92.7
1024	92.7	92.6	93.5	93.4
2048	97.6	97.8	98.5	97.8
4096	100.0	100.0	100.0	100.0

POTASSIUM ACETATE.

Table XVI. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	46.13	62.62	83.37	99.68
8	48.30	67.11	88.43	105.37
32	53.09	73.59	97.29	117.46
128	55.37	77.43	102.13	123.03
512	57.17	79.91	105.16	126.87
1024	58.33	81.14	106.84	128.09
2048	59.24	82.09	108.43	129.84
4096	59.06	81.89	108.65	129.90

Table XVII. - TEMPERATURE COEFFICIENTS.

	0° - 12.5°		12.5° - 25°		25° - 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	1.32	2.86	1.66	2.64	1.63	1.98
8	1.48	3.05	1.71	2.55	1.74	1.97
32	1.64	3.09	1.90	2.58	2.02	2.07
128	1.75	3.15	1.98	2.54	2.09	2.05
512	1.82	3.17	2.02	2.53	2.17	2.06
1024	1.83	3.14	2.06	2.54	2.23	2.09
2048	1.83	3.09	2.11	2.57	2.14	1.97
4096	1.83	3.10	2.14	2.61	2.13	1.96

Table XVIII. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	77.8	76.3	76.6	76.9
8	82.0	81.8	81.3	81.5
32	89.6	89.7	89.5	90.4
128	93.7	94.4	93.9	94.7
512	96.4	97.4	96.7	97.6
1024	98.4	98.9	98.3	98.3
2048	100.0	100.0	99.7	99.9
4096	99.6	99.8	100.0	100.0

POTASSIUM PERMANGANATE.

The strength of this solution was determined volu-
metrically by means of potassium tetroxalate.

Table XIX. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
8	59.34	80.17	104.36	134.74
32	63.75	87.13	113.70	139.05
128	66.76	91.38	119.31	142.42
512	66.46	91.14	117.90	141.49
1024	64.85	89.05	113.95	137.09
2048	63.72	86.81	110.80	133.03
4096	62.64	87.94	111.80	132.97

Table XX. - TEMPERATURE COEFFICIENTS.

	0° - 12.5°		12.5° - 25°		25° - 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
8	1.67	2.81	1.94	2.42	3.04	1.96
32	1.87	2.93	2.13	2.45	3.34	1.97
128	1.97	2.95	2.23	2.44	2.31	1.94
512	1.97	2.96	2.14	2.35	3.36	2.00
1024	1.95	3.02	1.99	2.24	2.31	2.03
2048	1.83	2.87	1.94	2.34	2.22	2.00
4096	2.02	3.23	1.91	2.17	2.21	1.99

Table XXI. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
8	88.8	87.7	87.5	87.3
32	95.4	95.3	95.3	95.5
128	100.0	100.0	100.0	100.0
512	99.5	99.7	98.8	99.4
1024	96.8	97.4	95.5	96.3
2048	95.4	94.8	92.9	92.4
4096	93.8	93.8	93.7	94.1

DI-POTASSIUM PHOSPHATE.

This salt was precipitated by magnesia mixture and the phosphoric acid determined.

Table XXII. – CONDUCTIVITY.

v.	0°	12.5°	25°	35°
2	63.01	83.82	113.04	138.16
8	79.19	109.25	143.54	174.91
32	91.69	127.42	167.81	203.80
128	102.47	142.37	188.10	230.71
512	107.76	150.85	199.40	238.84
1024	109.35	153.23	200.58	243.65
2048	110.47	157.04	206.13	242.54
4096	107.16	154.99	201.98	250.78

Table XXIII. – TEMPERATURE COEFFICIENTS.

v.	0° – 12.5° Cond. Units.	Per Cent.	12.5° – 25° Cond. Units.	Per Cent.	25° – 35° Cond. Units.	Per. Cent.
2	1.91	3.03	2.10	2.42	2.51	2.22
8	2.40	3.03	2.73	2.50	3.16	2.21
32	2.86	3.05	3.22	2.53	3.60	2.16
128	3.19	3.11	3.66	2.57	4.26	2.27
512	3.45	3.20	3.88	2.57	4.04	2.03
1024	3.43	3.14	3.86	2.54	4.21	2.10
2048	3.75	3.38	3.93	2.50	3.64	1.77
4096	3.83	3.57	3.76	2.43	4.38	2.42

Table XXIV. – PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
2	57.0	55.3	54.8	55.1
8	71.7	69.6	69.5	69.8
32	83.0	81.1	81.3	81.3
128	92.8	90.7	91.3	92.0
512	97.6	96.1	96.7	95.7
1024	99.0	98.0	97.5	96.8
2048	100.0	100.0	100.0	96.7
4096	97.0	98.7	98.0	100.0

This group consisting of strontium acetate, magnesium bromide, magnesium nitrate, magnesium formate and acetate will be considered next.

There is nothing special to note in the case of strontium acetate. It would readily hydrolyze, and any irregularities might easily be attributed to this fact. Attention might be called, however, to the increase in percentage dissociation with rise in temperature.

It is interesting in considering the data of the four magnesium compounds to discover, if possible, the effect of the different an-ions. Of course, the water of crystallization would also be a factor. This is the same, however, in the case of the bromide and nitrate and any difference in the conductivity of these two compounds may correctly be attributed to the differing anions.

On examining the data of these substances, it is readily seen that the conductivity of magnesium bromide is decidedly greater than that of magnesium nitrate. Its temperature coefficient of conductivity is also larger. This would point to some difference in the anions either as to velocity or complexity. Apart from their remarkable similarity, magnesium acetate and formate present nothing of special interest.

STRONTIUM ACETATE.

The strontium was precipitated and weighed as the carbonate.

Table XXV. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
2	34.94	49.86	66.58	81.11
8	56.51	80.19	106.96	129.99
32	70.69	100.80	135.25	164.88
128	81.89	117.19	157.69	193.44
512	88.50	128.09	170.10	209.22
1024	91.18	131.09	177.44	218.54
2048	97.30	139.01	180.07	219.77
4096	97.89	139.60	184.44	224.75

Table XXVI. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent
2	1.15	3.29	1.38	2.60	1.46	2.20
8	1.89	3.35	2.14	2.67	2.30	2.15
32	2.36	3.34	2.80	2.79	2.96	2.19
128	2.82	3.44	3.24	2.77	3.58	2.27
512	3.17	3.58	3.37	2.63	3.91	2.30
1024	3.19	3.50	3.70	2.82	4.08	2.30
2048	3.34	3.43	3.28	2.36	3.97	2.21
4096	3.34	3.41	3.59	2.57	4.03	2.19

Table XXVII. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
2	35.7	35.3	36.1	36.1
8	57.7	57.4	58.0	57.8
32	72.2	71.8	73.4	73.4
128	83.6	83.9	85.5	86.1
512	90.4	91.7	92.3	93.1
1024	93.1	93.9	96.4	97.1
2048	99.3	99.6	97.7	97.8
4096	100.0	100.0	100.0	100.0

MAGNESIUM BROMIDE.

The magnesium was precipitated as ammonium magnesium

phosphate and weighed as the pyro-phosphate.

Table XXVIII. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
2	76.54	104.05	132.92	162.25
8	93.73	130.13	170.64	206.18
32	104.56	147.24	194.42	235.51
128	113.52	159.94	211.91	257.31
512	118.93	167.72	223.06	270.40
1024	122.80	173.39	230.94	279.38
2048	127.28	179.74	238.70	289.52
4096	130.91	185.06	244.94	305.94

Table XXIX. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
2	2.22	2.91	2.31	2.22	2.93	2.20
8	2.91	3.11	3.24	2.49	3.55	2.08
32	3.41	3.26	3.77	2.56	4.11	2.11
128	3.71	3.27	4.16	2.60	4.54	2.14
512	3.90	3.28	4.43	2.64	4.73	2.12
1024	4.05	3.30	4.60	2.65	4.84	2.10
2048	4.20	3.30	4.72	2.63	5.08	2.13
4096	4.33	3.31	4.79	2.59	6.10	2.49

Table XXX. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
2	58.3	56.2	54.3	53.0
8	71.6	70.3	69.7	67.4
32	79.9	79.5	79.4	76.9
128	86.8	86.4	86.5	84.1
512	90.9	90.6	91.1	88.3
1024	93.9	93.7	94.3	91.3
2048	97.3	97.1	97.5	94.6
4096	100.0	100.0	100.0	1 0.0

MAGNESIUM NITRATE.

This was also weighed as the pyrophosphate.

Table XXXI. — CONDUCTIVITY.

v.	0°	12.5°	25°	35°
8	88.91	123.42	160.86	191.88
32	101.55	141.97	187.10	223.24
128	110.78	155.50	204.72	247.66
512	119.01	165.77	220.89	265.33
1024	120.68	170.27	224.49	272.30
2048	123.34	173.18	229.70	280.09
4096	122.89	173.70	229.58	277.54

Table XXXII. — TEMPERATURE COEFFICIENTS.

v.	0° – 12.5° Cond. Units.	Per Cent.	12.5° – 25° Cond. Units.	Per Cent.	25° – 35° Cond. Units.	Per Cent.
8	2.76	3.10	2.99	2.42	3.10	1.93
32	3.23	3.18	3.61	2.54	3.61	1.93
128	3.58	3.23	3.54	2.28	4.29	2.10
512	3.74	3.14	4.41	2.66	4.44	2.01
1024	3.97	3.28	4.34	2.55	4.78	2.12
2048	3.99	3.23	4.52	2.61	5.04	2.11
4096	4.06	3.30	4.47	2.57	4.80	2.09

Table XXXIII. — PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
8	72.1	71.1	70.0	68.5
32	82.4	81.7	81.5	79.7
128	89.9	89.5	89.1	88.4
512	96.5	95.4	96.2	94.7
1024	97.9	98.0	98.7	97.9
2048	100.0	99.7	100.0	100.0
4096	99.7	100.0	99.96	99.1

MAGNESIUM FORMATE.

This was precipitated and weighed as the preceding.

Table XXXIV. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
2	37.35	59.53	69.24	83.25
8	58.15	83.44	109.29	137.14
32	74.68	106.05	141.71	173.31
128	85.99	122.17	164.06	200.30
512	88.58	123.84	167.86	205.44
1024	94.03	133.87	178.23	208.90
2048	97.22	138.60	184.73	216.37
4096	97.18	138.74	182.91	223.19

Table XXXV. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
2	1.72	3.27	1.33	2.53	1.40	2.02
8	2.02	3.47	2.07	2.48	2.29	2.10
32	2.51	3.36	2.85	2.69	3.06	2.16
128	2.89	3.36	3.35	2.74	3.62	2.21
512	2.82	3.18	3.52	2.84	3.76	2.24
1024	3.19	3.39	3.38	2.52	3.37	1.91
2048	3.31	3.40	3.69	2.66	4.16	2.25
4096	3.32	3.42	3.53	2.54	4.03	2.20

Table XXXVI. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
2	38.4	37.9	37.5	36.8
8	59.8	60.1	59.2	58.4
32	76.8	76.4	76.7	76.1
128	88.4	88.1	88.8	88.5
512	91.1	89.3	90.9	90.7
1024	96.7	96.5	95.4	92.7
2048	99.9	99.9	100.0	100.0
4096	100.0	100.0	99.05	98.6

MAGNESIUM ACETATE.

The magnesium was determined as in the preceding.

Table XXXVII. — CONDUCTIVITY.

v	0°	12.5°	25°	35°
4	37.58	54.50	72.50	88.92
8	46.35	66.76	89.79	109.86
32	60.99	87.97	119.31	146.20
128	71.13	103.35	139.51	172.35
512	78.05	113.25	153.41	185.50
1024	80.38	116.73	158.95	201.71
2048	83.85	121.36	164.72	205.07
4096	84.99	121.76	165.38	205.70

Table XXXVIII. — TEMPERATURE COEFFICIENTS.

v.	0° — 12.5°		12.5° — 25°		25° — 35°	
	Cond. Units.	Per Cent.	Cond. Units	Per Cent.	Cond. Units.	Per Cent.
4	1.36	3.62	1.44	2.64	1.64	2.26
8	1.63	3.52	1.84	2.76	2.01	2.24
32	2.16	3.54	2.51	2.85	2.69	2.25
128	2.58	3.63	2.89	2.80	3.28	2.35
512	2.81	3.60	3.21	2.83	3.61	2.35
1024	2.91	3.62	3.38	2.89	4.28	2.69
2048	3.00	3.58	3.47	2.86	2.84	2.33
4096	2.94	3.46	3.49	2.87	2.83	2.32

Table XXXIX. — PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	44.2	44.8	43.8	43.7
8	54.6	54.8	54.3	53.9
32	71.8	72.2	72.1	71.8
128	83.7	84.9	84.3	84.6
512	91.9	93.0	92.8	93.0
1024	94.6	95.9	96.1	99.0
2048	98.7	99.7	99.6	99.7
4096	100.0	100.0	100.0	100.0

The next group taken up for consideration consists
of cadmium chloride, cadmium bromide, cadmium iodide and
lead chloride.   Attention should be called to the fact
that cadmium iodide, having no water of crystallization,
has just about the same temperature coefficients of conduct-
ivity as cadmium bromide and cadmium chloride; both of
which have water of crystallization.   Apparent increase
of percentage dissociation with rise in temperature is
unusual, and is quite noticeable in the case of cadmium
iodide.

Lead chloride has no water of crystallization but,
like cadmium iodide, has high temperature coefficients
of conductivity.   There must be some factor present
affecting temperature coefficients just as hydration does,
but which from the nature of the case cannot be due to
hydrates.

CADMIUM CHLORIDE.

Silver nitrate was used to precipitate cadmium chloride, cadmium bromide and cadmium iodide. They were weighed as silver bromide, chloride and iodide respectively.

Table XL. - CONDUCTIVITY.

v	0^0	12.5^0	25^0	35^0
4	33.65	46.21	60.15	71.92
8	45.32	60.85	79.30	94.59
32	65.63	90.33	118.55	142.48
128	88.54	122.98	162.32	195.71
512	106.14	148.36	197.57	236.99
1024	113.78	159.65	212.53	258.73
2048	121.19	166.23	221.36	269.00
4096	121.03	172.78	232.06	282.43

Table XLI. - TEMPERATURE COEFFICIENTS.

	0^0 - 12.5^0		12.5^0 - 25^0		25^0 - 35^0	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	1.00	2.97	1.12	2.42	1.18	1.96
8	1.24	2.74	1.47	2.42	1.53	1.93
32	1.97	3.01	2.26	2.50	2.39	2.02
128	2.77	3.14	3.15	2.54	3.34	2.06
512	3.38	3.18	3.94	2.66	3.94	1.99
1024	3.67	3.23	4.23	2.65	4.62	2.17
2048	3.60	2.97	4.41	2.65	4.76	2.10
4096	4.14	3.42	4.74	2.62	5.04	2.18

Table XLII. - PERCENTAGE DISSOCIATION.

v.	0^0	12.5^0	25^0	35^0
4	27.8	26.7	25.9	25.5
8	37.4	35.2	34.2	33.5
32	54.2	52.3	51.1	50.5
128	72.9	71.2	69.9	69.3
512	87.6	85.9	85.1	83.9
1024	93.9	92.4	91.6	91.6
2048	100.0	96.2	95.4	95.3
4096	99.9	100.0	100.0	100.0

CADMIUM BROMIDE.

Table XLIII. — CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	28.03	40.59	53.40	64.51
8	37.80	53.36	70.44	84.81
32	57.78	82.06	109.34	132.69
128	79.77	113.57	151.23	184.16
512	101.37	143.25	190.52	232.83
1024	110.69	156.85	208.48	252.81
2048	121.23	170.89	227.41	275.22
4096	123.76	174.05	232.20	280.84

Table XLIV. — TEMPERATURE COEFFICIENTS.

	0° — 12.5°		12.5° — 25°		25° — 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	0.96	3.35	1.02	2.51	1.11	2.07
8	1.24	3.28	1.37	2.56	1.44	2.03
32	1.94	3.35	2.18	2.66	2.34	2.14
128	2.70	3.38	3.01	2.65	3.29	2.18
512	3.35	3.30	3.78	2.64	4.23	2.22
1024	3.69	3.33	4.13	2.62	4.43	2.12
2048	3.97	3.21	4.52	2.64	4.78	2.10
4096	4.02	3.25	4.65	2.67	4.86	2.79

Table XLV. — PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	23.1	23.3	23.0	23.0
8	30.5	30.6	30.3	30.2
32	46.7	47.1	47.1	47.3
128	64.4	65.2	65.1	65.6
512	81.9	82.3	82.1	82.9
1024	89.4	90.1	89.8	90.0
2048	97.9	98.2	97.9	98.0
4096	100.0	100.0	100.0	100.0

CADMIUM IODIDE.

Table XLVI. —   CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	20.45	29.76	36.84	48.41
8	24.31	35.85	46.44	59.45
32	39.45	59.23	81.53	101.22
128	62.73	93.36	127.36	157.35
512	87.06	127.74	172.93	211.90
1024	96.31	140.03	188.66	231.10
2048	109.01	157.20	209.73	256.42
4096	118.78	170.69	224.93	271.27

Table XLVII. — TEMPERATURE COEFFICIENTS.

	0° — 12.5°		12.5° — 25°		25° — 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	0.75	3.67	0.81	2.72	0.86	2.16
8	0.92	3.78	1.01	2.82	1.10	2.27
32	1.58	4.01	1.78	3.01	1.97	2.42
128	2.45	3.90	2.72	2.91	3.00	2.36
512	3.25	3.73	3.62	2.83	3.90	2.26
1024	3.57	3.71	3.82	2.71	4.24	2.25
2048	3.86	3.54	4.20	2.67	4.67	2.23
4096	4.15	3.49	4.34	2.54	4.63	2.06

Table XLVIII. — PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	17.2	17.4	17.7	17.8
8	20.5	21.0	21.5	21.9
32	33.2	34.7	36.3	37.3
128	52.8	54.7	56.6	58.0
512	73.3	74.8	76.9	78.1
1024	81.0	82.6	83.9	85.2
2048	91.7	92.1	93.3	94.5
4096	100.0	100.0	100.0	100.0

LEAD CHLORIDE.

The lead was precipitated by means of sulphuric acid and
weighed as lead sulphate.

Table XLIX. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
64	104.41	144.76	188.71	224.76
128	116.27	161.56	211.43	252.17
512	133.16	186.16	246.31	295.05
1024	136.89	191.98	253.96	306.43
2048	138.88	195.16	258.49	312.13
4096	144.70	204.36	270.96	327.80

Table L. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
64	3.23	3.09	3.52	2.43	3.61	1.91
128	3.63	3.12	3.99	2.47	4.07	1.93
512	4.25	3.19	4.81	2.58	4.67	1.90
1024	4.41	3.22	4.96	2.58	5.25	2.07
2048	4.50	3.24	5.07	2.60	5.36	2.07
4096	4.77	3.30	5.27	2.58	5.75	2.13

Table LI. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
64	72.2	70.8	69.8	68.6
128	80.4	79.0	78.2	76.9
512	92.0	91.1	91.1	89.4
1024	94.6	93.9	94.0	93.5
2048	96.0	95.5	95.6	95.2
4096	100.0	100.0	100.0	100.0

The aluminium and chromium compounds will be taken
up next for discussion.   In these compounds we should expect
to find strong resemblances.   These are very apparent.
Chromium and aluminium compounds with respect to their con-
ductivities are in a class by themselves.   Their very large
conductivities and their exceedingly large temperature co-
efficients must attract attention.   Their very large con-
ductivities are due mainly to the great number of ions with
which they are capable of ionizing. Judging from their water
of crystallization and from freezing point lowering[1] they
must be hydrated to an enormous extent.   Their large temper-
ature coefficients of conductivity would also indicate this
to be the fact.   The change in conductivity both with rise
in temperature and with dilution is much more gradual in the
case of the aluminium salts than with those of chromium.
The extremely small percentage dissociation in concentrated
solutions, in the case of chromium sulphate and aluminium
sulphate is worthy of notice.   This is probably connected
with the fact that sulphates, especially in concentrated
solution, undergo marked polymerization.

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[1] Jones and Getman, *Amer. Chem. J*, 31, 305 (1904).

ALUMINIUM CHLORIDE.

The aluminium was determined by precipitating the hydrox-
ide and weighing as Al_2O_3. This was done also in the case of
aluminium nitrate and aluminium sulphate.

Table LII. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	105.90	147.40	193.51	232.54
8	120.22	168.23	220.86	266.58
32	142.21	200.06	265.12	322.18
128	162.66	231.08	308.80	377.28
512	176.77	252.75	341.24	421.06
1024	184.58	266.73	360.56	446.95
2048	193.37	279.49	381.44	472.46
4096	199.03	290.06	398.79	499.92

Table LIII. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5° Cond. Units.	Per Cent.	12.5° - 25° Cond. Units.	Per Cent.	25° - 35° Cond. Units.	Per Cent.
4	3.32	3.14	3.69	2.50	3.90	2.02
8	3.84	3.19	4.21	2.50	4.57	2.07
32	4.63	3.26	5.21	2.60	5.71	2.15
128	5.47	3.36	6.22	2.69	6.85	2.22
512	6.08	3.07	7.08	2.80	7.98	2.34
1024	6.57	3.55	7.51	2.82	8.64	2.40
2048	6.89	3.56	8.16	2.92	9.10	2.39
4096	7.28	3.66	8.70	3.00	10.11	2.54

Table LIV. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	53.2	50.8	48.5	46.5
8	60.4	58.0	55.4	53.3
32	71.5	69.0	66.5	64.4
128	81.7	79.7	77.4	75.5
512	88.8	87.1	85.5	84.2
1024	92.8	91.9	90.4	89.4
2048	97.2	96.3	95.6	94.5
4096	100.0	100.0	100.0	100.0

ALUMINIUM NITRATE.

Table LV. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	102.82	139.22	180.52	216.54
8	115.67	158.84	208.89	248.89
32	136.32	188.54	247.70	299.96
128	156.18	217.14	287.05	349.49
512	166.97	234.81	313.05	384.43
1024	177.45	247.08	332.20	410.18
2048	179.32	255.68	345.82	429.32
4096	187.89	272.12	372.07	462.84

Table LVI. - TEMPERATURE COEFFICIENTS.

	0° - 12.5°		12.5° - 25°		25° - 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	2.91	2.85	3.30	2.37	3.60	1.99
8	3.45	2.98	3.84	2.42	4.12	2.03
32	4.18	3.07	4.73	2.51	5.23	2.11
128	4.88	3.12	5.60	2.58	6.25	2.18
512	5.45	3.25	6.28	2.67	7.17	2.28
1024	5.63	3.40	6.86	2.77	7.86	2.36
2048	6.19	3.44	7.31	2.83	8.37	2.39
4096	6.90	4.53	8.19	2.95	9.32	2.45

Table LVII. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	54.7	51.2	48.5	46.8
8	61.6	58.4	55.6	53.8
32	72.5	69.3	66.6	64.9
128	83.1	79.8	77.1	75.6
512	88.9	86.3	84.1	83.1
1024	92.3	90.8	89.3	88.7
2048	95.4	94.0	92.9	92.6
4096	100.0	100.0	100.0	100.0

ALUMINIUM SULPHATE.

Table LVIII. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	51.90	71.81	92.40	107.72
8	65.21	89.81	114.44	132.46
32	89.50	123.63	158.01	183.51
128	131.87	169.38	219.04	206.22
512	164.08	230.86	301.01	358.79
1024	191.95	271.31	359.16	433.51
2048	222.31	317.20	425.03	512.19
4096	262.35	378.23	514.06	634.78

Table LIX. - TEMPERATURE COEFFICIENTS.

	0° - 12.5°		12.5° - 25°		25° - 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	1.59	3.06	1.65	2.30	1.53	1.66
8	1.97	3.02	1.97	2.19	1.80	1.57
32	2.73	3.05	2.75	2.23	2.55	1.61
128	3.80	3.12	3.97	2.34	4.72	2.16
512	5.34	3.25	5.61	2.43	5.78	1.79
1024	6.34	3.30	7.03	2.59	7.44	2.07
2048	7.59	3.41	8.63	2.72	9.32	2.19
4096	9.27	3.53	10.87	2.87	12.07	2.35

Table LX. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	19.8	19.0	18.0	17.0
8	24.9	23.7	22.3	20.9
32	34.1	32.7	30.7	28.9
128	46.5	44.8	42.6	41.9
512	62.5	61.0	58.5	56.5
1024	73.2	71.7	69.9	68.3
2048	84.7	83.9	82.7	81.6
4096	100.0	100.0	100.0	100.0

CHROMIUM CHLORIDE.

The chromium was precipitated and weighed as Cr_2O_3 in the case of both chromium chloride and chromium sulphate.

Table LXI. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	86.30	116.97	153.52	199.10
8	104.53	138.83	184.18	243.55
32	130.03	185.75	245.00	319.15
128	162.34	231.28	313.45	383.62
512	188.46	272.50	372.34	465.10
1024	200.21	294.55	405.58	504.31
2048	214.28	316.60	434.36	543.02
4096	228.73	341.14	467.61	580.16

Table LXII. - TEMPERATURE COEFFICIENTS.

	0° - 12.5°		12.5° - 25°		25° - 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	2.45	2.84	2.91	2.49	4.58	2.99
8	2.74	2.62	3.63	2.62	5.94	3.23
32	4.22	3.25	4.98	2.73	7.42	3.03
128	5.52	3.40	6.57	2.84	8.02	2.55
512	6.72	3.57	7.99	2.93	9.28	2.95
1024	7.54	3.77	8.72	2.96	10.07	2.50
2048	8.18	3.82	9.42	2.98	10.87	2.50
4096	8.91	3.88	10.12	2.97	11.26	2.41

Table LXIII. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	37.6	34.3	32.8	34.3
8	45.5	40.7	39.4	42.0
32	56.6	53.6	52.4	55.0
128	70.7	67.8	67.0	67.9
512	82.1	79.9	79.6	80.2
1024	87.2	86.4	86.3	86.9
2048	93.3	92.9	92.9	93.0
4096	100.0	100.0	100.0	100.0

CHROMIUM SULPHATE.

Table LXIV. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	58.14	78.48	99.64	116.41
8	77.85	105.64	130.18	151.17
32	120.59	156.67	197.34	230.37
128	169.08	225.80	283.58	338.07
512	216.36	293.66	376.23	472.16
1024	240.48	329.96	459.83	561.76
2048	293.38	405.65	534.55	708.14
4096	315.39	445.10	592.46	808.39

Table LXV. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	1.63	2.80	1.69	2.15	1.68	1.69
8	2.06	2.65	2.12	2.05	2.10	1.61
32	3.05	2.54	3.46	1.55	3.30	1.67
128	4.52	2.67	4.64	2.06	5.51	1.94
512	6.18	2.87	4.69	1.60	9.59	2.55
1024	7.16	2.98	10.39	3.15	10.10	2.22
2048	8.98	3.06	10.31	2.54	17.36	3.25
4096	10.38	3.29	12.86	2.75	20.98	3.51

Table LXVI. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	18.4	17.6	16.6	14.4
8	24.7	23.3	21.7	18.7
32	38.2	35.6	33.0	28.5
128	53.6	50.7	47.4	41.9
512	68.3	65.7	62.8	58.5
1024	76.2	74.1	76.8	69.5
2048	93.0	91.1	89.3	87.7
4096	100.0	100.0	100.0	100.0

In the next group will be considered manganous sulphate, silver nitrate, copper sulphate and cobalt bromide. Manganous sulphate calls for no comment. The data obtained for silver nitrate are remarkably similar to those obtained for ammonium nitrate. It apparently behaves as any other ordinary, unhydrated, binary compound. It differs from ammonium nitrate in that its percentage dissociation, apparently decreasing with rise in temperature from $0°$ to $25°$, increases somewhat at $35°$.

The data for copper sulphate resemble strikingly those obtained for manganous sulphate, cadmium bromide and cadmium iodide. At ordinary temperatures manganous sulphate and copper sulphate have the same amount of water of crystallization. That their temperature coefficients should be approximately the same is not surprising. But that the temperature coefficients of cadmium chloride and cadmium bromide, crystallizing with less water and cadmium iodide, crystallizing with no water, should be the same is surprising.

The temperature coefficients of cobalt bromide indicate much hydration as would be expected from its water of crystallization.

MANGANOUS SULPHATE.

The manganese was precipitated and weighed as the pyro-
phosphate.

Table LXVII. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	37.95	51.80	67.17	79.11
8	44.11	61.37	79.77	94.06
32	59.65	83.47	109.27	128.72
128	79.46	111.74	147.24	176.10
512	97.99	138.76	184.58	228.69
1024	107.12	152.31	203.94	245.72
2048	116.15	165.28	221.33	268.33
4096	124.47	177.56	238.20	289.39

Table LXVIII. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5° Cond. Units.	Per Cent.	12.5° - 25° Cond. Units.	Per Cent.	25° - 35° Cond. Units.	Per Cent.
4	1.16	3.11	1.23	2.38	1.19	1.77
8	1.38	3.13	1.47	2.40	1.43	1.79
32	1.91	3.20	2.06	2.47	2.05	1.88
128	2.58	3.25	2.84	2.54	2.89	1.96
512	3.26	3.33	3.67	2.64	3.81	2.06
1024	3.62	3.38	4.05	2.66	4.28	2.11
2048	3.93	3.38	4.48	2.71	4.70	2.13
4096	4.25	3.42	4.85	2.73	5.12	2.15

Table LXIX. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	29.9	29.2	28.2	27.3
8	35.4	34.6	33.5	32.5
32	47.9	47.0	45.9	44.8
128	63.8	62.9	61.8	60.8
512	78.7	78.1	77.5	76.9
1024	86.1	85.8	85.2	84.9
2048	93.3	93.1	92.9	92.7
4096	100.0	100.0	100.0	100.0

SILVER NITRATE.

The silver was precipitated as chloride and weighed.

Table LXX. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	51.43	70.55	91.63	109.95
8	56.01	76.68	99.80	120.37
32	61.80	85.30	111.20	133.14
128	65.79	91.06	119.14	142.67
512	69.24	94.99	125.23	148.77
2048	69.83	96.67	126.81	151.24
4096	71.03	99.03	129.68	153.32

Table LXXI. - TEMPERATURE COEFFICIENTS.

	0° - 12.5°		12.5° - 25°		25° - 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	1.53	2.98	1.69	2.40	1.83	2.00
8	1.65	2.95	1.85	2.15	2.06	2.06
32	1.88	2.94	2.07	2.43	2.19	1.97
128	2.02	2.94	2.25	2.47	2.35	1.97
512	2.06	2.98	2.42	2.55	2.35	1.88
2048	2.15	3.01	2.41	2.49	2.44	1.92
4096	2.24	3.15	2.45	2.47	2.36	1.82

Table LXXII. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	72.4	71.3	70.6	71.7
8	78.8	77.4	76.9	78.5
32	87.0	86.2	85.7	86.8
128	92.6	92.0	91.8	93.1
512	97.4	95.9	96.5	97.0
2048	98.3	97.6	97.7	98.7
4096	100.0	100.0	100.0	100.0

COBALT BROMIDE.

This salt was precipitated by means of silver nitrate and
the bromine determined from the weight of silver bromide
obtained.

Table LXXIII. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	87.82	120.24	155.60	196.30
8	95.04	131.29	171.30	204.48
32	105.56	147.10	193.09	233.04
128	115.88	162.19	214.03	259.91
512	119.47	169.42	224.49	273.44
1024	120.80	173.38	231.56	281.16
2048	124.00	174.68	234.28	283.65
4096	125.45	177.93	236.78	289.34

Table LXXIV. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	2.59	2.95	2.83	2.35	4.07	2.62
8	2.90	3.05	3.20	2.44	3.32	1.94
32	3.32	3.15	3.68	2.50	4.00	2.07
128	3.71	3.20	4.15	2.56	4.59	2.15
512	4.00	3.35	4.41	2.60	4.90	2.18
1024	4.21	3.49	4.65	2.68	4.96	2.14
2048	4.05	3.27	4.77	2.73	4.84	2.07
4096	4.20	3.35	4.71	2.65	5.26	2.22

Table LXXV. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	70.0	67.6	65.7	67.8
8	75.7	73.8	72.3	70.7
32	84.1	82.7	81.5	80.5
128	92.3	92.0	90.4	89.8
512	95.2	95.2	94.8	94.5
1024	96.3	97.5	97.8	97.2
2048	98.8	98.2	98.9	97.7
4096	100.0	100.0	100.0	100.0

COPPER SULPHATE.

The sulphuric acid in this salt was precipitated and
weighed as barium sulphate.

Table LXXVI. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
2	30.06	42.12	55.11	65.15
8	42.30	59.35	77.33	91.16
32	57.24	80.53	105.64	124.94
128	76.91	108.74	143.21	170.60
512	97.88	138.92	184.97	221.08
1024	105.85	150.86	202.57	245.05
2048	113.36	161.78	217.71	264.44
4096	119.18	171.07	231.37	281.43

Table LXXVII. - TEMPERATURE COEFFICIENTS.

	0° - 12.5°		12.5° - 25°		25° - 35°	
v.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
2	0.96	5.19	1.04	2.47	1.00	1.82
8	1.36	3.22	1.44	2.43	1.38	1.79
32	1.86	3.25	2.01	2.50	1.93	1.83
128	2.54	3.30	2.76	2.54	2.74	1.91
512	3.28	3.35	3.68	2.65	3.61	1.95
1024	3.60	3.40	4.14	2.74	4.25	2.10
2048	3.87	3.41	4.47	2.76	4.67	2.15
4096	4.15	3.48	4.82	2.82	5.02	2.17

Table LXXVIII. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
2	25.2	24.6	23.8	23.2
8	35.5	34.7	33.4	32.4
32	48.0	47.1	45.7	44.4
128	64.5	63.6	61.9	60.6
512	82.1	81.2	80.0	78.6
1024	88.8	88.2	87.6	87.1
2048	95.1	94.6	94.1	94.0
4096	100.0	100.0	100.0	100.0

The conductivity values obtained for uranyl sulphate and uranyl acetate do not agree satisfactorily with those obtained by West[1]. His solutions were evidently standardized on a different basis. It should be noticed that the temperature coefficients in conductivity units of uranyl sulphate decrease with rise in temperature through v = 517. After this dilution they increase as in the case of the other uranyl salts. The percentage dissociation of uranyl acetate apparently increases with rise in temperature through v = 128. The more dilute solutions show a decrease with rise in temperature. This may be seen in the curve for uranyl acetate which follows.

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[1] Amer Chem. Journal. <u>44</u>, 537, (1910).

URANYL CHLORIDE.

Uranyl chloride, nitrate, sulphate and acetate were
precipitated by means of ammonium hydroxide and weighed
as U_3O_8.

Table LXXIX. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	101.45	139.09	180.45	214.70
8	110.48	157.64	206.01	246.51
32	133.05	186.56	246.13	297.84
128	148.39	209.75	279.00	339.40
512	155.98	220.70	296.56	360.44
1024	161.02	231.37	311.92	383.88
2048	168.42	242.69	328.24	405.98
4096	174.98	254.22	348.16	433.68

Table LXXX. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	3.01	2.97	3.51	2.38	3.43	1.90
8	3.77	3.41	3.87	2.46	4.05	1.97
32	4.28	3.22	4.76	2.55	5.17	2.10
128	4.91	3.31	5.54	2.64	6.04	2.17
512	5.18	3.32	6.07	2.75	6.39	2.16
1024	5.63	3.50	6.44	2.78	7.20	2.31
2048	5.94	3.53	6.84	2.82	7.77	2.37
4096	6.34	3.62	7.52	2.96	8.55	2.46

Table LXXXI. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	58.0	54.7	51.8	49.5
8	63.1	62.0	59.2	56.8
32	76.0	73.4	70.7	68.7
128	84.8	82.5	80.2	78.2
512	89.1	86.8	85.2	83.1
1024	92.0	91.0	89.6	88.5
2048	96.3	95.5	94.3	93.6
4096	100.0	100.0	100.0	100.0

URANYL NITRATE.

Table LXXXII. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
4	74.91	102.01	132.91	158.84
8	83.44	114.71	150.57	181.20
32	97.22	136.35	180.64	219.38
128	110.14	153.84	207.89	254.21
512	116.33	166.65	224.95	277.35
1024	123.14	177.76	241.47	298.63.
2048	128.92	187.20	255.38	317.44
4096	136.77	200.10	274.50	343.09

Table LXXXIII. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
4	2.17	2.90	2.47	2.42	2.59	1.95
8	2.50	3.00	3.07	2.68	3.06	2.03
32	3.13	3.22	3.54	2.60	3.87	2.14
128	3.66	3.32	4.16	2.67	4.63	2.25
512	4.03	3.47	4.66	2.80	5.24	2.33
1024	4.37	3.55	5.10	2.87	5.72	2.37
2048	4.66	3.62	5.46	2.92	6.21	2.43
4096	.5.07	3.71	5.95	2.97	6.86	2.50

Table LXXXIV. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
4	54.8	51.0	48.4	46.3
8	61.0	57.3	54.9	52.8
32	71.1	68.1	65.8	63.9
128	80.5	77.9	75.8	74.1
512	85.0	83.3	82.0	80.8
1024	90.0	88.8	88.0	87.1
2048	94.2	93.6	93.1	92.5
4096	100.0	100.0	100.0	100.0

URANYL SULPHATE.

Table LXXXV. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
8	76.13	99.77	120.82	136.43
32	100.65	129.52	156.80	176.52
128	128.62	166.72	203.02	229.42
512	157.54	207.90	257.69	295.20
1024	175.68	235.28	296.95	343.01
2048	191.68	260.77	332.57	391.00
4096	205.33	285.05	373.65	446.33

Table LXXXVI. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5° Cond. Units.	Per Cent.	12.5° - 25° Cond. Units.	Per Cent.	25° - 35° Cond. Units.	Per Cent.
8	1.73	2.22	1.68	1.68	1.56	1.29
32	2.31	2.30	2.18	1.68	1.97	1.26
128	3.05	2.37	2.90	1.74	2.64	1.30
512	4.03	2.56	3.98	1.91	3.75	1.46
1024	4.77	2.72	4.93	2.10	4.61	1.55
2048	5.53	2.89	5.74	2.20	5.84	1.76
4096	6.54	3.22	7.09	2.49	7.27	1.95

Table LXXXVII. - PERCENTAGE DISSOCIATION.

v.	0°	12.5°	25°	35°
8	38.4	35.0	32.3	30.6
32	49.5	45.4	42.0	39.6
128	63.2	58.5	54.3	51.4
512	77.5	72.9	69.0	66.2
1024	86.4	82.5	79.5	76.9
2048	94.2	91.5	89.0	87.6
4096	100.0	100.0	100.0	100.0

URANYL ACETATE.

Table LXXXVIII. - CONDUCTIVITY.

v.	0°	12.5°	25°	35°
8	30.59	42.75	56.53	68.12
32	39.65	55.08	72.25	86.67
128	51.48	70.66	91.34	108.58
512	65.57	86.06	110.47	129.06
1024	70.13	94.74	120.37	141.12
2048	76.81	103.65	131.78	154.46
4096	83.75	113.81	145.10	170.54

Table LXXXIX. - TEMPERATURE COEFFICIENTS.

v.	0° - 12.5°		12.5° - 25°		25° - 35°	
	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.	Cond. Units.	Per Cent.
8	0.97	3.12	1.10	2.57	1.16	2.05
32	1.23	3.10	1.37	2.49	1.44	1.99
128	1.53	2.97	1.65	2.34	1.72	1.88
512	1.80	2.85	1.95	2.26	1.86	1.68
1024	1.97	2.81	2.05	2.16	2.08	1.73
2048	2.15	2.80	2.25	2.17	2.27	1.72
4096	2.41	2.88	2.50	2.20	2.54	1.75

Table XC. - PERCENTAGE DISSOCIATION.

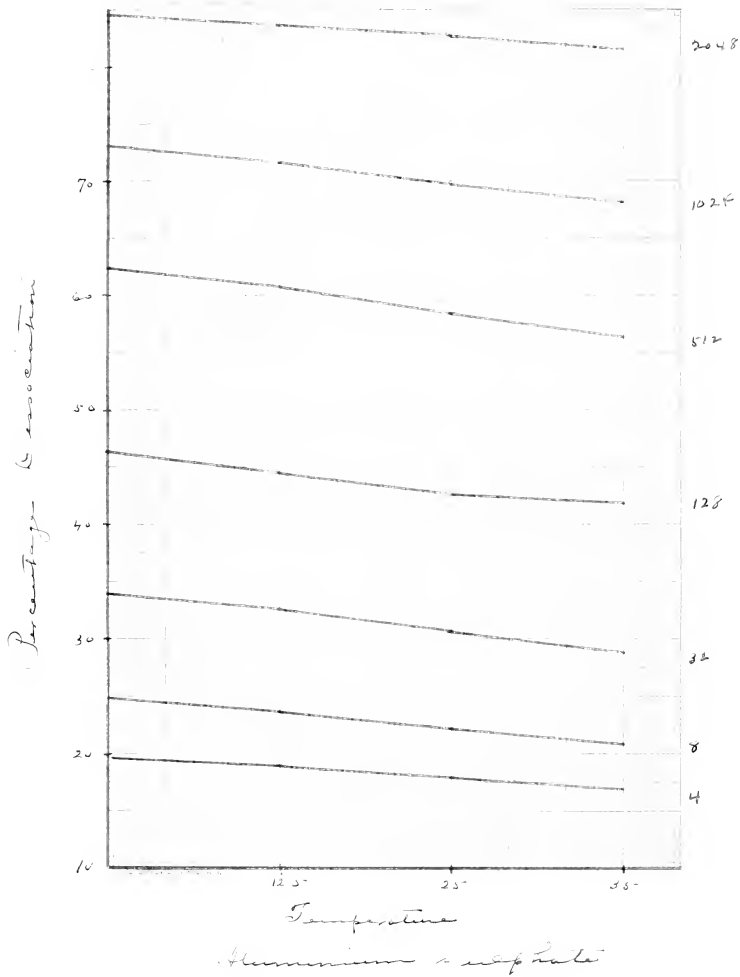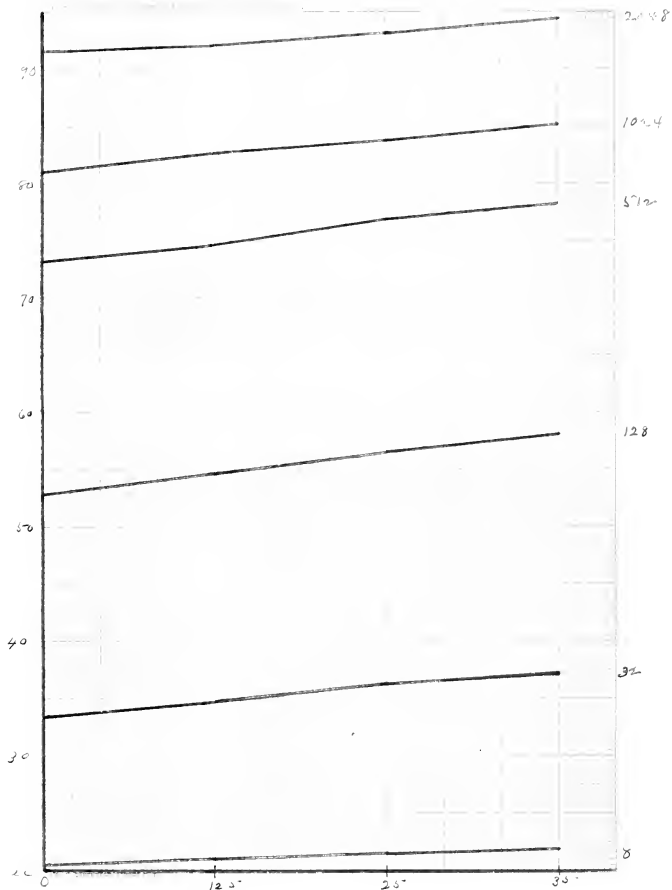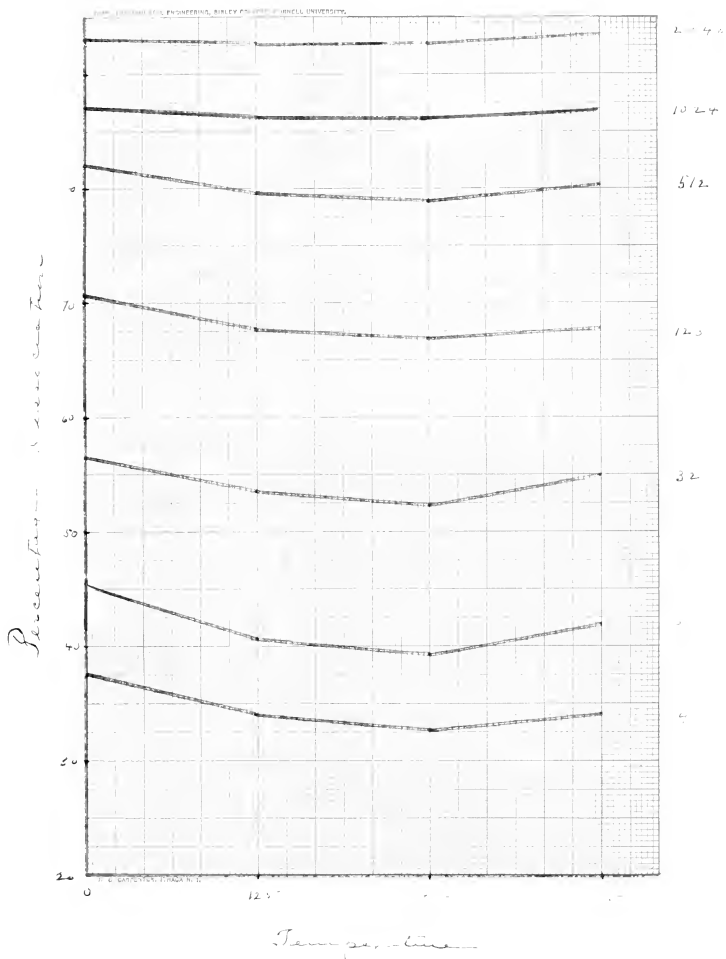| v.	0°	12.5°	25°	35°
8	36.5	37.6	39.0	40.0
32	47.3	48.4	49.8	50.8
128	61.5	62.1	63.0	63.7
512	75.9	75.6	76.1	75.7
1024	83.7	83.3	83.0	82.8
2048	91.7	91.1	90.8	90.6
4096	100.0	100.0	100.0	100.0

Plate I

Plate II

Percentage Dissociation (vertical axis)
Temperature (horizontal axis)

Cadmium Iodide

Plate III.

Chromium Chloride

Plate IV

Plate VI

Silver Nitrate
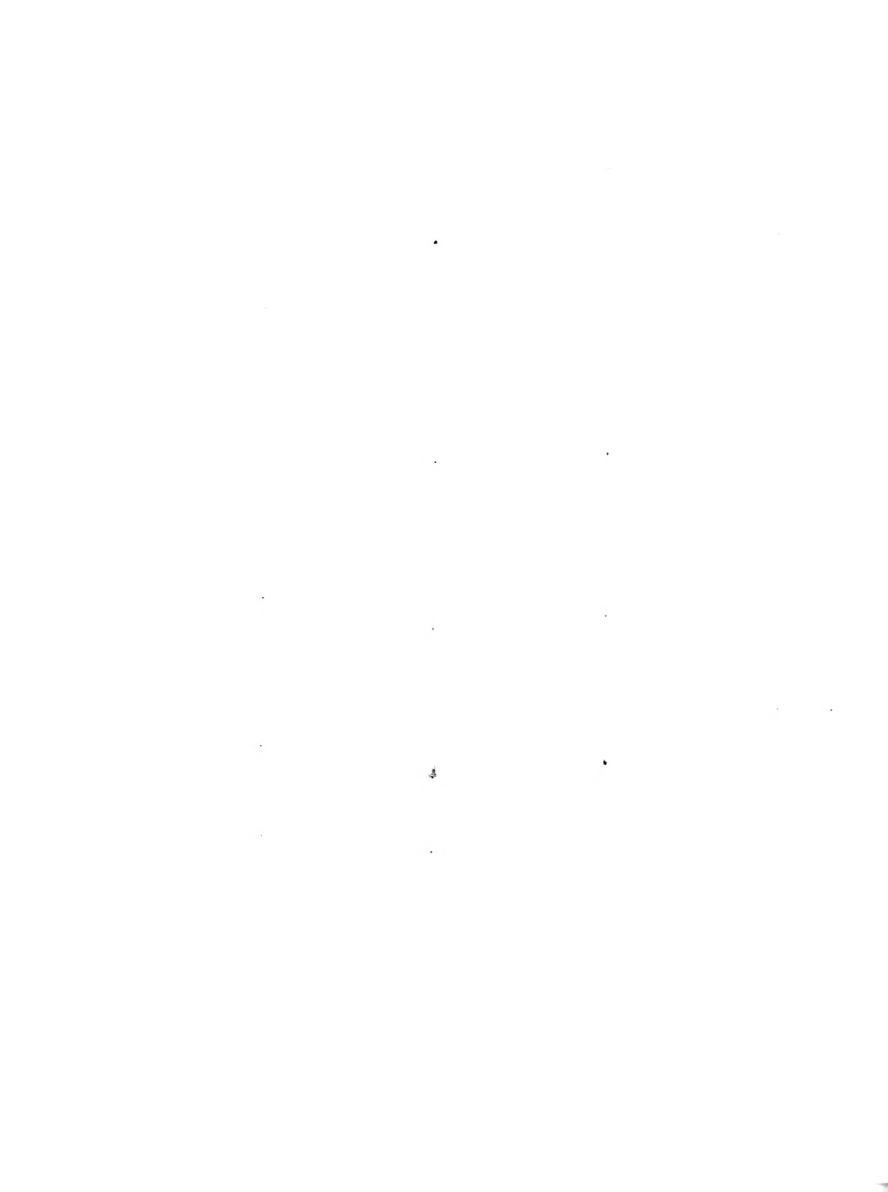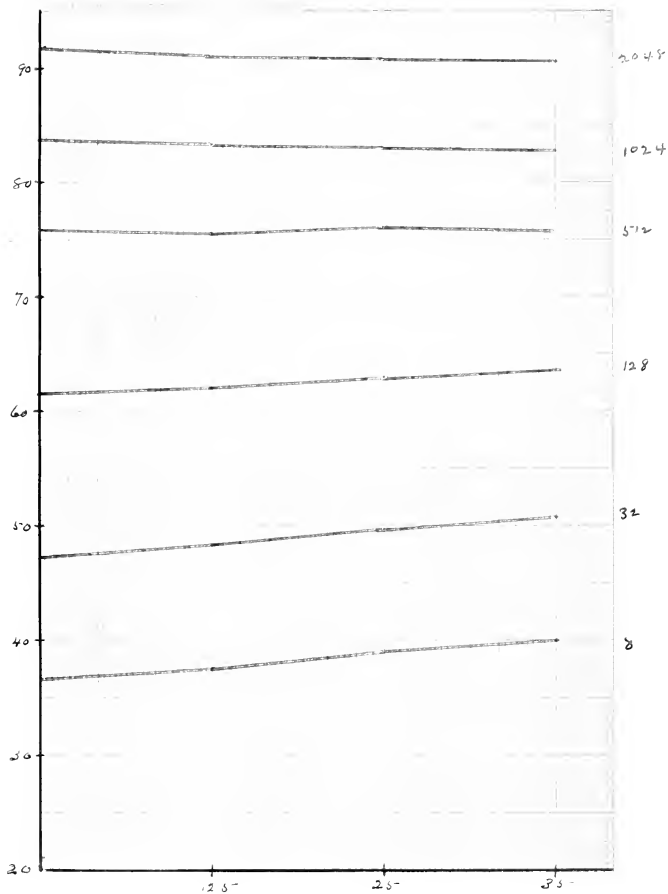
Plate VI.

Percentage Dissociation
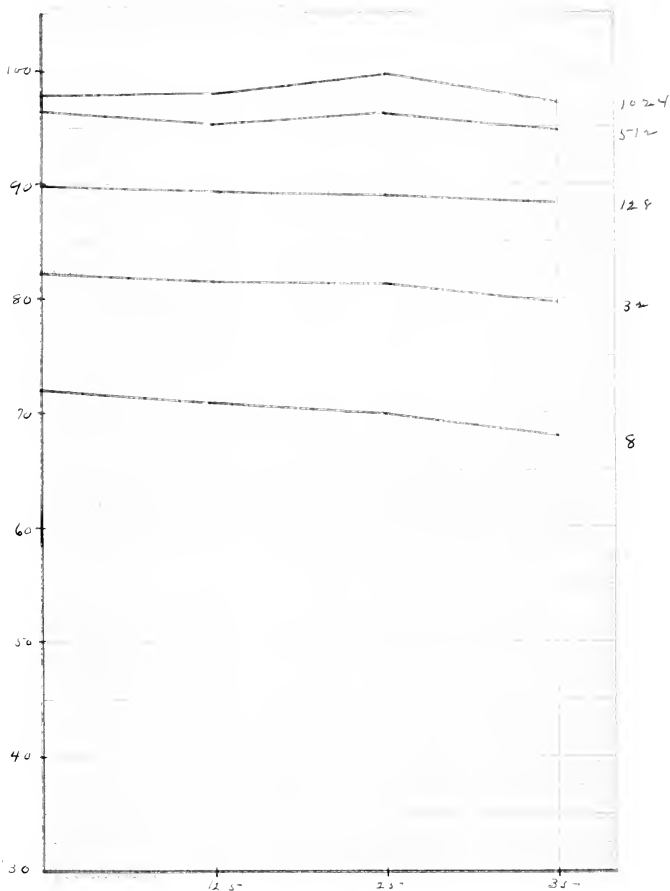
Temperature

Magnesium nitrate

Plate IV

P L A T E S .
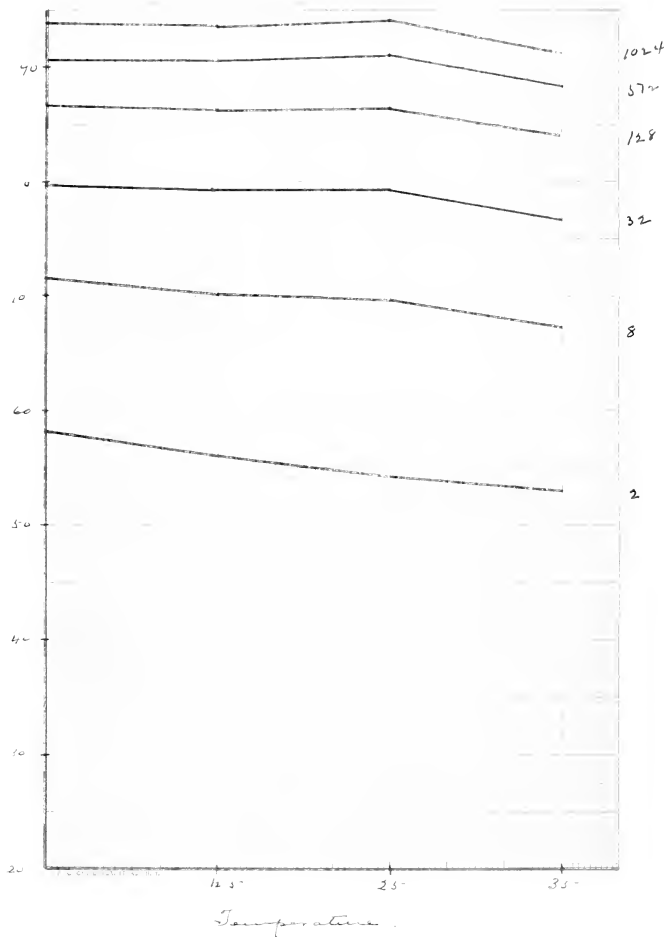
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So far little or nothing has been said in regard to
the percentage dissociation of the salts studied.
Attention will be called to these by means of curves. The
curves of ten of the thirty salts showed the percentage
dissociation to be almost a linear function of rise in
température. Plotting percentage dissociation as ordinates
against rise of temperature as abscissae for each dilution,
curves were obtained in ten cases out of the thirty re-
sembling the one for aluminium sulphate, Plate I.   The
other 20 salts all showed maxima or minima variations.
Some of these were very slight.   Diagrams of the most
striking variations will follow.   The salts giving curves
showing the percentage dissociation to be a linear function
of rise in temperature were acid ammonium sulphate, alu-
minium nitrate, aluminium chloride, aluminium sulphate,
uranyl chloride, uranyl sulphate, uranyl nitrate, chromium
sulphate, cadmium chloride and manganous sulphate.   The
others showed more or less variation; the most striking of
which are here represented.

Plate II is very interesting, showing in the case of
of cadmium iodide the increase in percentage dissociation
with rise of temperature from $v = 8$ to $v = 2048$.

Plate III.   From the curve it is easily seen that the

percentage dissociation of chromium chloride increases decidedly with rise in temperature between 25° and 35°. The increase becomes less and less as the dilution increases.

Plate IV. Uranyl acetate shows an increase in percentage dissociation in the more concentrated solutions, but at greater dilutions gives a falling curve.

Plate V. Silver nitrate shows a decided increase in percentage dissociation with rise in temperature from $v = 4$ to $v = 2048$.

Plates VI and VII. The curves representing magnesium nitrate and magnesium bromide show a remarkable resemblance. The maxima at higher dilutions are decided.

After an examination of the curves the question arises, what produces this variation? The increase in percentage dissociation with rise in temperature would, naturally, be thought to be due to hydration. But when there is little or no hydration the question becomes more difficult to answer. If, however, the ions are assumed to be complex, rise in temperature would bring about greater dissociation and the effect would be just the same as if hydrates had been present. It is difficult to differentiate the two factors. That hydrates exist is not doubted. The complexity of the ions is not so well established, so that I shall present arguments only for the latter. If the change were a gradual increase it might be attributed easily to hydration, but a change from an

increase to a decrease in dissociation could not be accounted for in this way, whereas complex ions once dissociated might reach a state where recombination would take place.   Moreover, the amount of hydration has been found to depend on the amount of water of crystallization. In several of the preceding salts, notably in the case of cadmium compounds, cadmium iodide, which has no water of crystallization, is found to have temperature coefficients of conductivity equal in magnitude to those of cadmium chloride, cadmium bromide and copper sulphate all of which have water of crystallization.   Lead chloride, also, which has no water of crystallization, has temperature coefficients which compare well with those of substances that are much hydrated, i.e., copper sulphate and cobalt bromide.   This would indicate that there must be some other factor present producing the same effect as hydration.

SUMMARY.

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1.   In the main the results obtained in the case of these thirty salts tend to confirm the results already obtained.

2.   Without exception conductivity has increased with rise in temperature and with dilution.

3.   The temperature coefficients of conductivity expressed in conductivity units, with two exceptions, increase with rise in temperature; while the temperature coefficients expressed in per cent decrease.

4.   Salts greatly hydrated have large temperature coefficients.   The amount of hydration, judged by the temperature coefficients, seems closely related to the water of crystallization.

5.   The exceptions to the results already obtained, viz:− an increase in percentage dissociation with rise in temperature and a large temperature coefficient when there is no reason to expect large hydration, point, in the opinion of the author, strongly to the view advanced above that inductive action takes place through the solvent between charged ions and neutral molecules and that this gives rise to complex molecules and ions in solution.

BIOGRAPHY.

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Lula Gaines Winston, the author of this dissertation, is a daughter of Professor Charles H. Winston, LL.D., of Richmond College, Virginia.   Having graduated at the Richmond High School, she entered Richmond College and received the degree of B. S. in 1899.

Since that time she has attended the Harvard Summer School for three years, taking courses in Chemistry and Physics.

During the session 1900 − 1901, she was teacher of Science in the Richmond Female Seminary.   In 1901 she was elected teacher of Chemistry and Physics in the State Female Normal School, Farmville, Virginia, which position she still holds, having been given leave of absence for the past two years to pursue her studies at Johns Hopkins University.